Digital quantum magnetism on a trapped-ion quantum computer

Portability dossier - benchmark

agQSL portability pipeline

2026-06-07

Field	Value
Slug	`2026-nature-digital-quantum-magnetism`
Source	journal
Link	https://www.nature.com/articles/s41586-026-10445-3
Category	benchmark
Triaged	2026-05-21 by port_until_julien_parallel
Bootstrapped	2026-06-07

Paper: fetch failed — see `paper.url`

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1 Capability note

1.1 Claim

Quantinuum's H2-1 and H2-2 56-qubit trapped-ion computers ran digitised (Trotterised) quench dynamics of 2D quantum Ising magnets on lattices of up to 56 sites, with the deepest circuits exceeding 2000 two-qubit gates, suppressing digitisation error well enough to observe thermalisation on timescales that the authors argue severely challenge classical simulation.

1.2 Vendor and machine

Quantinuum System Model H2, specifically the H2-1 and H2-2 trapped-ion (QCCD) 56-qubit quantum computers. Four quench experiments were distributed across the two machines: the low-temperature quench ran on both H2-1 and H2-2; the intermediate-temperature quench on H2-2 only; the hydrodynamics quench on H2-1 only; and the triangular-lattice quench on H2-2 only. Software / compiler stack: not reported in the extracted text. Published in Nature vol. 653, pp. 56-62 (2026); open preprint arXiv:2503.20870 (submitted 26 March 2025, last revised 21 April 2026).

1.3 Metrics

Metric	Value	Source
QV / linear XEB / etc.	Not reported (no QV or XEB benchmark; the figure of merit is classical-simulation hardness of the dynamics, not a standard benchmark)	arXiv:2503.20870
1Q gate fidelity	Not reported	arXiv:2503.20870
2Q gate fidelity	99.94(1)% native partial-entangler fidelity	arXiv:2503.20870
Circuit depth sustained	up to 16 Trotter steps; deepest circuits have over 2000 two-qubit gates	arXiv:2503.20870

Metric	Value	Source
Qubit count used	up to 56 (7×8 and 14×4 square lattices); 54 (9×6 triangular lattice)	arXiv:2503.20870
Shots / repetitions	Not reported as a raw count (error analysis uses bootstrap resampling)	arXiv:2503.20870

1.4 Context

This pushes Quantinuum's H2 application-scale digital simulation onto the full 56-qubit register at circuit depths above 2000 two-qubit gates, leaning on the device's high native two-qubit fidelity (99.94(1)%) and all-to-all QCCD connectivity to keep deep Trotterised circuits coherent without analogue approximations. It joins the broader wave of beyond-classical digital-simulation claims (e.g. IBM's 127-qubit utility-scale Ising experiment) but trades raw qubit count for fidelity and connectivity. The threshold crossed is "classically hard digital dynamics" of a 2D quantum magnet, not a formal hardware milestone such as a new quantum-volume record. The Ezratty 2025 index corroborates Quantinuum's steady quantum-volume growth through 2020-2025 and flags this digitised-Ising line of work.

1.5 Caveats

This is a peer-reviewed Nature paper with a matching open arXiv preprint, so the "blog post, no peer review" flag does not apply. Limits to note: single-qubit gate fidelity and raw shot counts are not printed in the extracted text, so the per-circuit sampling cost cannot be reconstructed from the figures here. The beyond-classical framing rests on classical-simulation-hardness arguments for the chosen quenches rather than a standard, vendor-agnostic benchmark, so it is not directly comparable to a QV or XEB number. The calendar dates of the experimental runs are not reported.